

Behavioral and Physiological Response of Baleen Whales to Ships and Ship Noise

John Calambokidis
Cascadia Research Collective
218 ½ W. 4th Ave.
Olympia, WA 98501
phone: (360) 943-7325 fax: (360) 943-7026 email: calambokidis@cascadiaresearch.org

Award Number: N000141310772
www.CascadiaResearch.org

LONG-TERM GOALS

We began this study in 2013 with goal of examining the behavioral and physiological response of blue whales to ships and ship noise off California using a combination of opportunistic and controlled research. Ship noise has been identified as the major source of anthropogenic noise in the oceans especially in areas of high vessel traffic. Ship strikes are also a growing concern especially for several species including blue and right whales that appear to be particularly susceptible. In initial research, we demonstrated the feasibility of documenting whale response to opportunistic close approaches of ships made possible by the presence of high levels of ship traffic particularly to the ports of LA/Long Beach passing through areas of known high concentrations of blue whales. This juxtaposition has resulted in high levels of ship strikes (Berman-Kowalewski et al. 2010) as well as potential impacts on vocal detections of blue whales (Melcon et al. 2012). In this study we continue research on behavioral response of blue whales to ship close approaches and specifically examine how this varies with ship speed; this is one strategy proposed to mitigate ship strikes. We will also test the response of blue whales to controlled playback of ship noise to examine the specific cues blue whales respond to and also to allow comparison between how blue whales respond to ship noise and other anthropogenic sounds like mid-frequency sonar. To gain insight into whether ship noise and frequent passages of ships might be causing a stress response, we will compare stress hormone levels in blue whales feeding for extended periods in areas of high ship traffic with those feeding away from shipping lanes.

OBJECTIVES

Our objectives include:

1. Determine behavioral response (avoidance and changes in dive behavior) of blue whales and other large mystecetes to exposure to close approaches by ships.
2. Examine the stimulus that appears to trigger the response to ships and whether this is a response to ship noise or the presence of the ship.

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 30 SEP 2013		2. REPORT TYPE		3. DATES COVERED 00-00-2013 to 00-00-2013	
4. TITLE AND SUBTITLE Behavioral and Physiological Response of Baleen Whales to Ships and Ship Noise			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Cascadia Research Collective, 2187 W. 4th Avenue, Olympia, WA, 98501			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 4	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

3. Examine how reaction varies with differences in ship speed and approach.
4. Determine sound exposure of a whale directly in the path of a ship.
5. Examine whether chronic exposure to ship noise causes a noticeable change in stress hormones (Keller et al. 2006, 2009).

APPROACH

Our overall approach to achieve our objectives involves:

- Continuation of the work on reaction of whales to ships focused on increasing sample size of ships moving at different speeds and additional species of whales. Focus would include work with full speed ships in the Santa Barbara Channel (now that 1 December 2011 changes in the CARB regulations on clean burning fuel are resulting in ships returning to the shipping lanes through the Channel) and slower ships near the entrances to Los Angeles/Long Beach Harbors.
- Conduct controlled exposure experiments (CEE) using ship noise to blue whales using identical methodologies to the SOCAL BRS (Southall et al. 2012, 2013) to allow direct comparison of blue whale response to ship noise to that from other anthropogenic sources like mid-frequency sonar (MFA). Response to playback may or may not be similar to the response to close approaches of real ships being conducted opportunistically. This will also allow comparison to the response of right whales to ship noise from distant ships and playback (Nowacek et al. 2004) using somewhat similar methodologies.
- Obtain measurements of ship noise in the path of ships representing what whales at risk of a ship strike would experience using autonomous drifting recording hydrophones in the path of ships.
- Collect and examine stress hormone levels in biopsy samples from blue whales feeding in areas of high ship traffic such as off LA/Long Beach Harbor, especially over multiple days, compared to those from blue whales feeding farther from shipping lanes.

WORK COMPLETED

Work began on the study in mid to late 2013 so only initial project activities occurred in FY2013. Work completed to date includes:

1. Collaboration with Moss Landing Marine Laboratories (Dr. Jim Harvey and graduate student Angela Szesciorka) on tag designs to provide longer term deployments of archival tags especially for work with humpback whales off northern California. This included initial tests on some modified suction cup designs.
2. Coordination with Channel Islands National Marine Sanctuary for use of their vessel in initial field efforts in 2014 off southern California.
3. Coordination with collaborators at SWFSC for testing of stress hormones in later stages of this project.
4. Conducted field efforts in 2013 as a part of other ongoing projects but which will provide some of the data to be used in the current study (McKenna et al. 2011, In Prep., Calambokidis et al. 2011, 2013). This included deployments of suction cup tags on blue

whales near shipping lanes in southern California and humpback and blue whales near shipping lanes off northern California.

5. Work has continued on the SOCAL Behavioral Response Study (under separate funding) including additional deployments and Controlled Exposure Experiments of blue whales to simulated Navy sonar and starting in 2013 real Navy ships using 53C sonar that will serve as an important basis of comparison for results from this study.

RESULTS

This project began only in late 2013 (Awarded in Sept 2013 with a start date of 15 August 2013) so results there are no results yet from the initial work completed. Work has continued in 2013 on related projects (related to ship strike risk and the SOCAL-Behavioral Response Study) that will be valuable contributions and part of the comparison dataset related to analysis of the current study.

RELATED PROJECTS

This project is being conducted in collaboration with several other related efforts:

1. Collaboration with Moss Landing Marine Laboratories (Dr. Jim Harvey and graduate student Angela Szesciorka) on tag designs to provide longer term deployments of archival tags especially for work with humpback whales off northern California.
2. Collaborators with Dr. Nick Kellar at SWFSC who will be receiving funding from ONR for the testing of stress hormones in later stages of this project. This component while an integral part of this study is being funded separately from our award because it is going to another federal agency.
3. Field effort in 2013 was conducted in coordination and with support of NOAA including the Channel Islands National Marine Sanctuary as a part of an ongoing project examining ship strike risk to whales off California.
4. The SOCAL Behavioral Response Study to Navy sonar (funded by the Navy's Living Marine Resources program) will serve as an important basis of comparison for results from this study.

REFERENCES

- Berman-Kowalewski, M., F.M.D. Gulland, S. Wilkin, J. Calambokidis, B. Mate, J. Cordaro, D. Rotstein, J. St. Leger, P. Collins, K. Fahy, and S. Dover. 2010 Association between blue whale (*Balaenoptera musculus*) mortality and ship strikes along the California coast. *Aquatic Mammals* 36: 59-66.
- Calambokidis, J., M.F. McKenna, E.M. Oleson, J. Goldbogen, and K. Stingle. 2011. Examination of blue whale vulnerability to ship strikes in the Santa Barbara Channel based on sightings, photo-ID, and multiple tag types. Presentation/Proceedings at the 19th Biennial Conference on the Biology of Marine Mammals. Tampa, FL.
- Calambokidis, J and J. Barlow. 2013. Trends in humpback and blue whales off the US West Coast and their relationship to ship strike mortality. Abstract (Proceedings) 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, NZ, December 2013.

- Kellar, N.M., M.L. Trego, C.I. Marks, S.J. Chivers, K. Danil, and F.I. Archer. 2009. Blubber testosterone: A potential marker of male reproductive status in short-beaked common dolphins. *Marine Mammal Science* 25: 507-522.
- Kellar, N.M., M.L. Trego, C.I. Marks, and A.E. Dizon. 2006. Determining pregnancy from blubber in three species of delphinids. *Marine Mammal Science* 22: 1-16.
- McKenna, M.F., J. Calambokidis, J.A. Goldbogen, and E.M. Oleson. 2011. Behavioral Response of Blue Whales to the Presence of Large Commercial Ships. Presentation/Proceedings at the 19th Biennial Conference on the Biology of Marine Mammals. Tampa, FL.
- Melcón M.L., A.J. Cummins, S.M. Kerosky, L.K. Roche, S.M. Wiggins, and J.A. Hildebrand. 2012. Blue Whales Respond to Anthropogenic Noise. *PLoS ONE* 7(2): e32681. doi:10.1371/journal.pone.0032681
- Nowacek, D.P. M. P. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. *Proc. R. Soc. Lond. B* 271(1536):227-231.
- Southall, B.L., D. Moretti, B. Abraham, J. Calambokidis, S.L. DeRuiter, and P.L. Tyack. 2012. Marine Mammal Behavioral Response Studies in Southern California: Advances in Technology and Experimental Methods. *Marine Technology Society Journal* 46(4): 46-59.
- Southall, B, Calambokidis, J. Moretti, D, Barlow, J, DeRuiter, S, Goldbogen, J, Friedlaender, A, Hazen, E, Stimpert, A, Arranz, P, Falcone, E, Schorr, G, Douglas, A, Kyburg, C, Tyack, P. 2013. Measuring Cetacean Responses to Military Sonar: Behavioral Response Studies in southern California (SOCAL-BRS). Abstract (Proceedings) 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, NZ, December 2013.